STATEK

Miniature Crystals 600 kHz to 2 MHz

CX-1 Series   Actual Size   CX-2 Series

MODEL CX-1H/2H for Series Oscillators
MODEL CX-1V/2V for Pierce Oscillators

Features

Low-profile, hermetically-sealed package

Ideal for use with microprocessors

Available without leads for surface mounting

High shock resistance

Excellent aging characteristics

Full military testing available

Description

H-Model crystals are intended for use in series (two cascaded inverters) oscillators. V-Model crystals are for use in Pierce (single inverter) oscillators. Both are available in a rugged, miniature ceramic package. CX crystals are manufactured by a Statek-developed photolithographic process.

Specifications: 600 kHz to 2 MHz

Specifications are typical at 25°C unless otherwise noted. Specifications subject to change without notice.

Calibration tolerance	Calibration A: $\pm$0.05%
	Calibration B: $\pm$0.1%
	Calibration C: $\pm$1.0%
Load Capacitance	7pf
Motional Resistance, R_1	See Figure 1
	H model: 5kΩ maximum
	V model: 3kΩ maximum
Motional Capacitance, C_1 ...	See Figure 2
Quality Factor, Q	See Figure 3
Shunt Capacitance, C_o	1.0 pf typical
Drive Level	H model: 5 μW maximum
	V model: 3 μW maximum
Frequency-Temperature Stability*	-0.008%, 0-70°C
	-0.025%, -40 to $+85$°C
	-0.045%, -55 to $+125$°C
Aging, first year	10 ppm maximum
Shock, survival	750g, 1 ms, ½ sine
Vibration, survival	10g rms, 10-2000 Hz random
Standard Frequencies	1.0, 1.048576, 1.2288, 1.8432, 2.0 MHz

*Does not include calibration tolerance. Positive variations small compared to negative variations.
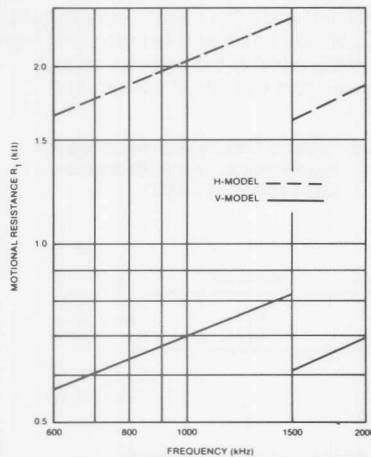
FIGURE 1. Typical Motional Resistance, R_1

FIGURE 2. Typical Motional Capacitance, C_1
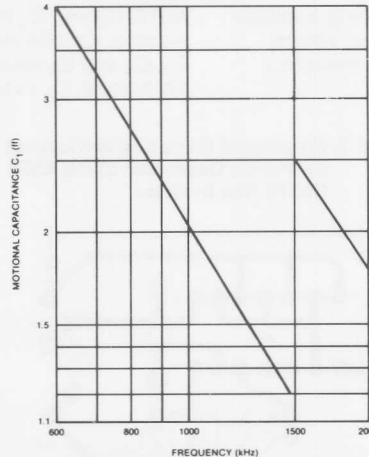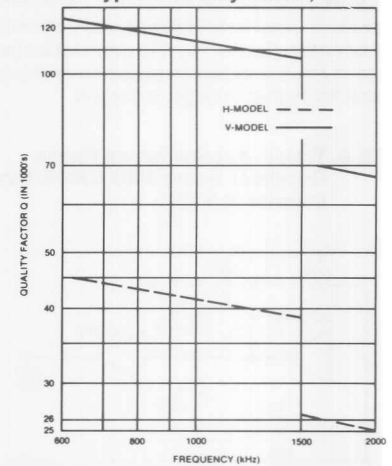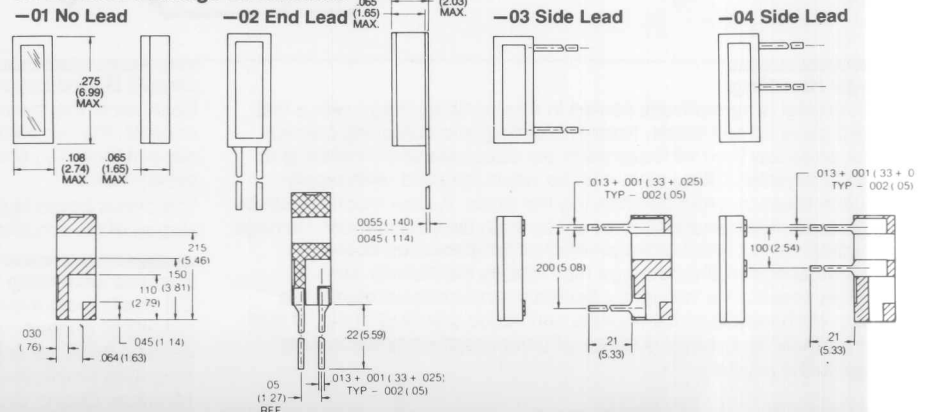

FIGURE 3. Typical Quality Factor, Q

CX-1 Series Package Dimensions

DIM	IN.	MM	NOTES
A	0.330	8.38	Max
B	0.155	3.94	Max
C	0.080	2.03	Max
D	0.300±0.01	7.62±0.25	
E	0.125	3.18	Min
F	0.040	1.02	Max
G	0.045	1.14	Nom
H	0.105	2.67	Nom
J	0.060	1.52	Nom

Leads 0.010'' × 0.018'' (0.25 × 0.46mm) nom

CX-2 Series Package Dimensions

—01 No Lead   —02 End Lead   —03 Side Lead   —04 Side Lead

Model CX-1H/2H for Series Oscillators

H-Model crystals are designed for applications requiring rapid start-up, small size, ruggedness, high reliability and long service/storage life. H-Model crystals in a series oscillator are ideally suited for low-cost, high-volume applications. Series oscillators are usually designed using two cascaded inverters as shown in Figure 4. The crystal oscillates at a frequency, f_o, 5 to 50 ppm below the series resonant frequency, f_s, of the crystal. The reactance of the crystal is capacitive in a series oscillator. Circuit layout capacitance across the crystal will degrade oscillator stability. Typical component values for a series oscillator using a 1 MHz, H-model crystal with a 4069 CMOS hex inverter are shown in Figure 4.

Drive Level

Resistors R_A and R_B, in conjunction with C_2, provide the necessary phase leading function and also provide a proper crystal drive level.

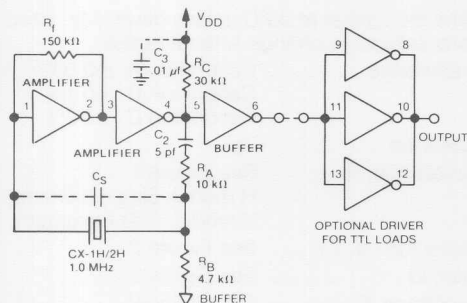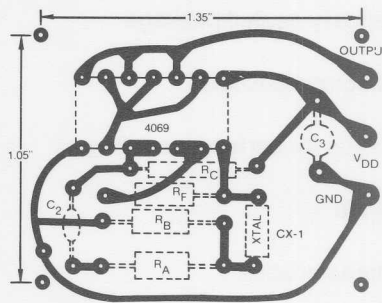**FIGURE 4. Typical Application as Series Oscillator Using 4069 CMOS Hex Inverter at 5V DC**

FIGURE 5. Suggested Circuit Board Layout for Series Oscillator Using 4069 CMOS Hex Inverter

Model CX-1V/2V for Pierce Oscillators

V-Model crystals are designed for applications requiring small size, ruggedness, high stability and low current consumption. V-Model crystals are designed for use in Pierce (single inverter) oscillators and are ideal for battery-powered microprocessor applications. The conventional CMOS Pierce oscillator is shown in Figure 6. The crystal oscillates at a frequency f_o, 15 to 150 ppm above the crystal's series-resonant frequency f_s. The crystal is effectively inductive and, in combination with C_D and C_G in the feedback loop, provides approximately 180° phase shift necessary to sustain oscillation. Typical component values for a Pierce oscillator using a 1 MHz V-Model crystal with a 4069 CMOS hex inverter are shown in Figure 6.

Drive Level

Resistor R_A is used to limit the crystal's drive level by forming a voltage divider between R_A and C_O. R_A also stabilizes the oscillator against changes in R_O, the output impedance of the amplifier. R_A should be increased for higher voltage operation.

Load Capacitance (C_L)

V-Model crystal frequency calibration is based on a load capacitance defined as the capacitance which, when added in series with the crystal in an impedance meter, will produce the frequency of operation in the intended oscillator circuit. C_L is related to C_D, C_G and C_S in Figure 6 approximately as follows:

$$C_L \approx \frac{C_D \times C_G}{C_D + C_G} + C_S$$

NOTE: C_D and C_G include stray layout and other circuit capacitances. In practice, the effective value of C_L will be less than that calculated from C_D, C_G and C_S values because of the effect of the amplifier output impedance. C_S should be minimized and should not exceed 1 pf.

FIGURE 6. Typical Application as Pierce Oscillator Using 4069 CMOS Hex Inverter at 5 VDC
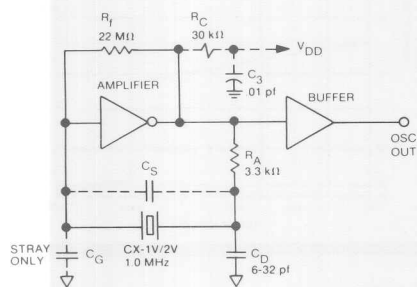

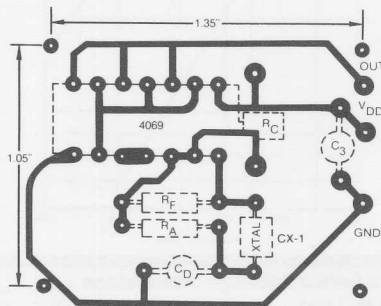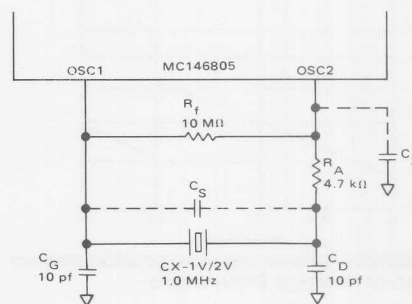**FIGURE 7. Suggested Circuit Board Layout for Pierce Oscillator Using 4069 CMOS Hex Inverter**

FIGURE 8. Typical CMOS Microprocessor Application Using Motorola MC 146805 at 5VDC

Package Handling

The CX crystal is hermetically sealed in a ceramic package with a soft soldered glass lid and leads. Normal handling and soldering precautions for small low thermal mass parts are adequate when installing or testing CX crystals. CX crystals may be wave soldered, with proper precaution taken to avoid desoldering the leads. A slow machine rate or too high a pre-heat temperature or solder bath temperature can damage the crystals. If the crystal lackage reaches temperatures above the maximums specified the package may lose its hermeticity. Loss of hermeticity results in a frequency decrease and motional resistance increase. Mishandling of CX crystals can cause cracking of the lid and loss of hermeticity. Excessive shock of unmounted parts can cause damage to the crystal.

Circuit Board Layout

Because of the low motional capacitance associated with miniature crystals, the oscillator designer must be concerned with layout. Stray capacitance (C_S) should be kept below 1pf for best oscillator performance.

The circuit board layout should minimize coupling between different stages of the amplifier and oscillator circuit.

Surface Mounting

CX crystals are available without leads for surface mounting on hybrid circuits or printed circuit boards. Seal rim temperature should not exceed 210°C for standard products. For high-temperature surface-mounting processes, refer to data sheet titled "Surface Mountable Miniature Quartz Crystals".